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Naftali Herscovici  
*Atlantic Microwave Corporation*

Francisco Lerma  
*Technological University Dublin*

Max Ammann  
*Technological University Dublin, [max.ammann@tudublin.ie](mailto:max.ammann@tudublin.ie)*

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# A New Architecture for a Multi Polarized, Perpendicularly-Fed, Radiating Element

Naftali Herscovici <sup>(1)</sup>, F. Leon-Lerma <sup>(2)</sup>, and M. J. Ammann <sup>(2)</sup>,

<sup>(1)</sup>Atlantic Microwave Corp (tuli@atlanticmicrowave.com)

<sup>(2)</sup>Centre for Telecommunications Value chain-driven Research  
Dublin Institute of Technology, Ireland.

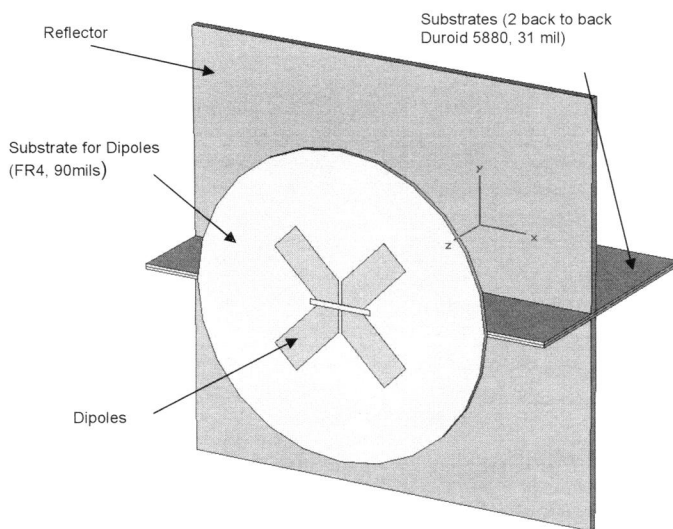
**Abstract** Planar printed antennas, are often required to be fed by parallel feed-networks, which, when printed on the same substrate as the radiating elements, create mutual coupling, spurious radiation and excite surface waves. This considerably affects the array efficiency.

Numerous architectures were proposed in the past; some of them use the multilayer structure (which by itself exhibits low efficiency), or perpendicularly fed structures. The latter consist of a substrate for the radiating element and another substrate which for the feed-network. The paper reviews some of the basic configurations proposed until now, and shows the specific improvements introduced by the proposed architecture.

## 1. INTRODUCTION

The goal of this development was to design a wide-band circularly polarized printed element, which can be easily integrated in an array, and separates the radiating space from the beamformer. Specifically we mainly refer to types of arrays where the scanning is achieved in one plane by means of a microwave lens (such as a Rotman Lens or a Butler matrix) and a fixed beam in the other plane. Linearly polarized elements suitable for this purpose are well known: LTSA (with its variation), the quasi-Yagi dipole, and other types of printed dipoles. The main drawback of these elements is that *the only polarization achievable with these elements is linear and the polarization vector has to be parallel to the substrate*.

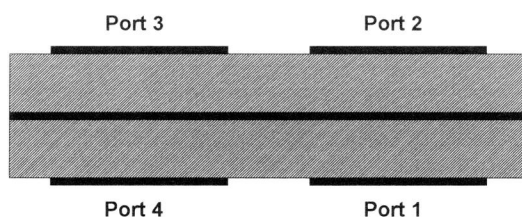
These limitations are significant and some effort was invested in the development of alternatives. In [1, 2], an aperture-fed patch fed by a perpendicular substrate is presented, in which the polarization of the element is perpendicular to the feeding substrate. In [3], the problem seems to be solved; however the solution is achieved using *a pair of crossed dipoles with one feeding point*. This architecture does not allow switchable polarizations. The architecture proposed consists of two back-to-back microstrip substrates perpendicularly feeding a pair of crossed dipoles (Figure 1). Each half-dipole is individually fed by a microstrip line. The four microstrip lines are fed separately and by suitably arranging the phase of each feed, all polarizations are achievable: ie. linear (horizontal, vertical and  $\pm 45^\circ$ ), and circular (RHCP or LHCP). In all polarization modes, the polarization vector is independent of the orientation of the substrate.



**Figure 1** – The proposed radiating element

## 2. DESIGN

The basic idea of the proposed architecture is to feed each half-dipole independently from the other half dipoles with reference to a common ground. By properly phase feeding each of the half-dipoles, all the polarization can be created. Table I summarizes the polarization options and Figure 2 shows the port notation. Considering the field orientations, one of the half-dipoles printed on the same substrate is inherently out of phase with the pair printed on the other substrate. Table I ignores this, assuming that the feed network takes care of that.



**Figure 2** – Port notation

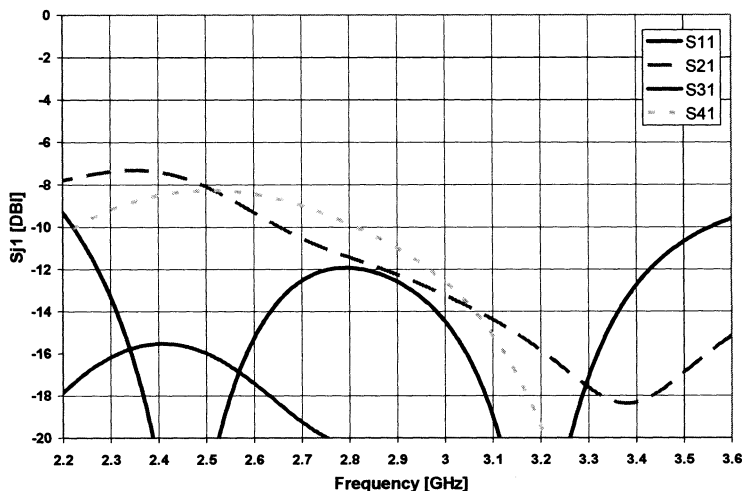
**Table I**

| Polarizations | Dipole_port1 | Dipole_port2 | Dipole_port3 | Dipole_port4 |
|---------------|--------------|--------------|--------------|--------------|
| Vpol          | 180          | 0            | 0            | 180          |
| Hpol          | 180          | 180          | 0            | 0            |
| +45°          | 180          | loaded       | 0            | loaded       |
| -45°          | loaded       | 180          | 0            | loaded       |
| RHCP          | 0            | 90           | 180          | 270          |
| LHCP          | 270          | 180          | 90           | 0            |

The four half-dipoles are individually fed by microstrip lines and are separated by  $\lambda/4$  from a planar reflector. A square hole in the reflector, allows the microstrip line to pass through, with no interaction between the reflector and the lines, and very little impact on the front-to-back ratio of the antenna. A  $\lambda/4$  slot was introduced in the ground plane to minimize the mutual coupling between the co-planar lines.

### 3. RESULTS

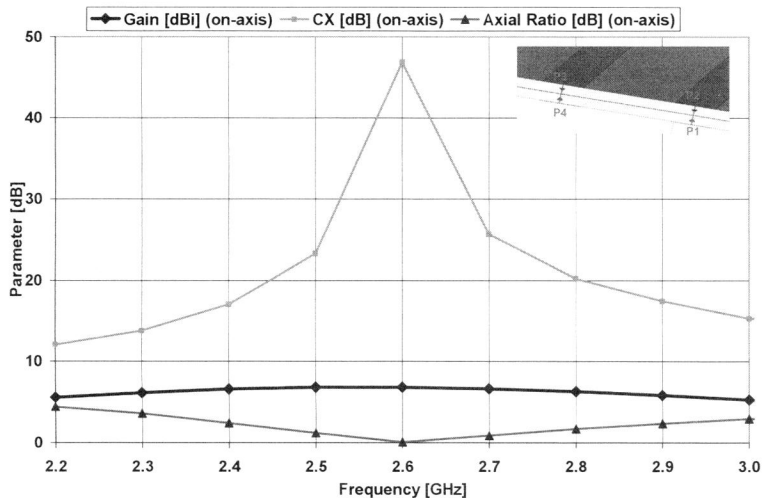
The circular polarized (LHCP) version was designed using CST Microwave Studio and IE3D. The layout is absolutely symmetric with respect to both x- and y-axes so the simulated S-parameters for Port1 only are shown in Figure 3.

**Figure 3 – S-parameters**

As shown in Figure 3, the mutual coupling between ports is still relatively high, probably due to surface waves. In the future, the possibility of introducing slots in the substrate

itself will be investigated. The return loss is less than 10 dB over a more than 50% bandwidth. Figure 4, summarizes the main parameters of the antenna such as gain, axial ratio, and the crosspolarization level with respect to the peak of the copolar pattern (both on-axis). It seems that the antenna operates very well over an overall of more than 25% assuming:

- a. Axial ratio < 2.5 dB (on-axis)
- b. Crosspol level < -20 dB (on-axis)
- c. Gain < Max Gain - 1 dB
- d. Return Loss < -10 dB



#### 4. CONCLUSIONS

A New Architecture for a Multi Polarized, Perpendicularly-Fed, Radiating Element was presented. Unfortunately, at the time of the writing of this paper, the antenna was not ready for testing. Measured data will be given in the presentation.

#### REFERENCES

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